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[1] CALCIUM
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TITANIUM
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URANIUM MINERALS

[3] ABSORPTION SPECTROSCOPY
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# APPLICATION OF GEOCHEMICAL EXPLORATION IN THE KAP FRANKLIN AREA, NORTHERN EAST GREENLAND

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## ABSTRACT

More than 800 stream sediments, soil, seepage soil and water samples collected during the field seasons of 1974 and 1975 in the Kap Franklin area, northern East Greenland, were analysed for K, Ca, Ti, Mn and Fe by radioisotope energy-dispersive X-ray fluorescence, and for U by delayed-neutron counting. Samples were also analysed for V, Cu, Zn and Pb by atomic absorption spectrophotometry.

Areas with known mineralisation are outlined by anomalous Zn and Pb contents in stream sediments and soils. A predominantly mechanical dispersion mechanism is deduced from the similarity in the chemistry of bedrock, stream sediments and soils. Narrow dispersion halos following from this observation suggest that dense sampling procedures are required. The usefulness of Cu, Zn and Pb water geochemistry is not proved.

There is reasonable agreement between a reconnaissance study and detailed investigations carried out in 1974 and 1975, respectively. The distribution patterns for Cu, Zn, Pb and U were more clearly displayed by means of the detailed sampling, and the metal contents in stream sediments were found to decrease rapidly downstream. Soil and seepage soil sampling between tributaries was shown to be advantageous. A test of daily and weekly variations of Cu, Zn and Pb in stream sediments of selected sampling sites demonstrated changes in the metal contents of generally less than 10 per cent.

Data from soil samples in the Randbøldal clearly outline the extent of U mineralisation. There is good correlation between U, and Zn and Pb in both stream sediments and soils.

CONTENTS

# 1. INTRODUCTION

Previous prospecting carried out in East Greenland by the Geological Survey of Greenland[1,2] had comprised an airborne radiometric and magnometer survey. As geochemical prospecting in the area had been only limited, a study was initiated in 1974 to investigate whether known techniques of geochemical exploration could be applied to an arctic terrain.

The Kap Franklin area covers about 200 $km^2$ and is situated between latitudes $73^o\ 15'$ and $73^o\ 22'$, about 150 km north-east of Mesters Vig. The climate is arctic and snow usually covers the area for 10 months of the year. In July and August small tributaries transport large masses of melted snow and ice to major streams in broad glacier-eroded valleys. By August most of the land up to altitudes of 800 m is free of snow. The vegetation is of typically high-arctic type. Above large alluvial fans at altitudes of about 300 m, the rock exposures are generally good, thus permitting rock sampling.

During the two-month field season small field teams are usually served once a week by helicopter from a base camp. Under normal weather conditions, about 30 geochemical samples can be collected daily by a two-man field team.

Stream sediments, soil and water samples were collected with a density of about 1 sample/$km^2$ in 1974 in four drainage systems of the Kap Franklin area (Fig. 1): (1) Randbøldal, (2) South of Knuden (S of K), (3) Kejser Franz Josephs Fjord (KFJ Fjord), and (4) Vilddal. Sampling in the Randbøldal was intensified in 1975 to about 6 samples/$km^2$. The samples were analysed for K, Ca, Ti, Mn and Fe by radioisotope energy-dispersive X-ray fluorescence analysis (EDX), for V, Cu, Zn and Pb by atomic absorption spectrophotometry (AAS), and for U by delayed-neutron counting.

In this report the sampling methods and analytical procedures are described. The metal distribution in the different samples is compared and the areal distribution discussed. The results of the intensified sampling in the Randbøldal in 1975 are compared with those of the sampling in 1974. The seasonal variation of the metal content of samples from selected sites in Randbøldal is discussed, and analytical data from soil sampling traverses in this area are presented.

## 2. GEOLOGY AND MINERALISATION

The Kap Franklin area (Fig. 1) consists of terrestrial sediments and magmatic rocks of Devonian age with marine deposits of Permian, Lower Triassic and Middle Cretaceous ages resting unconformably on the Devonian strata in the western and northern part of the area. Tertiary basalts occur as flows, sills and dykes. The geology has been described by Bütler[3], Gräter[4], and Alexander-Marrack & Friend[5].

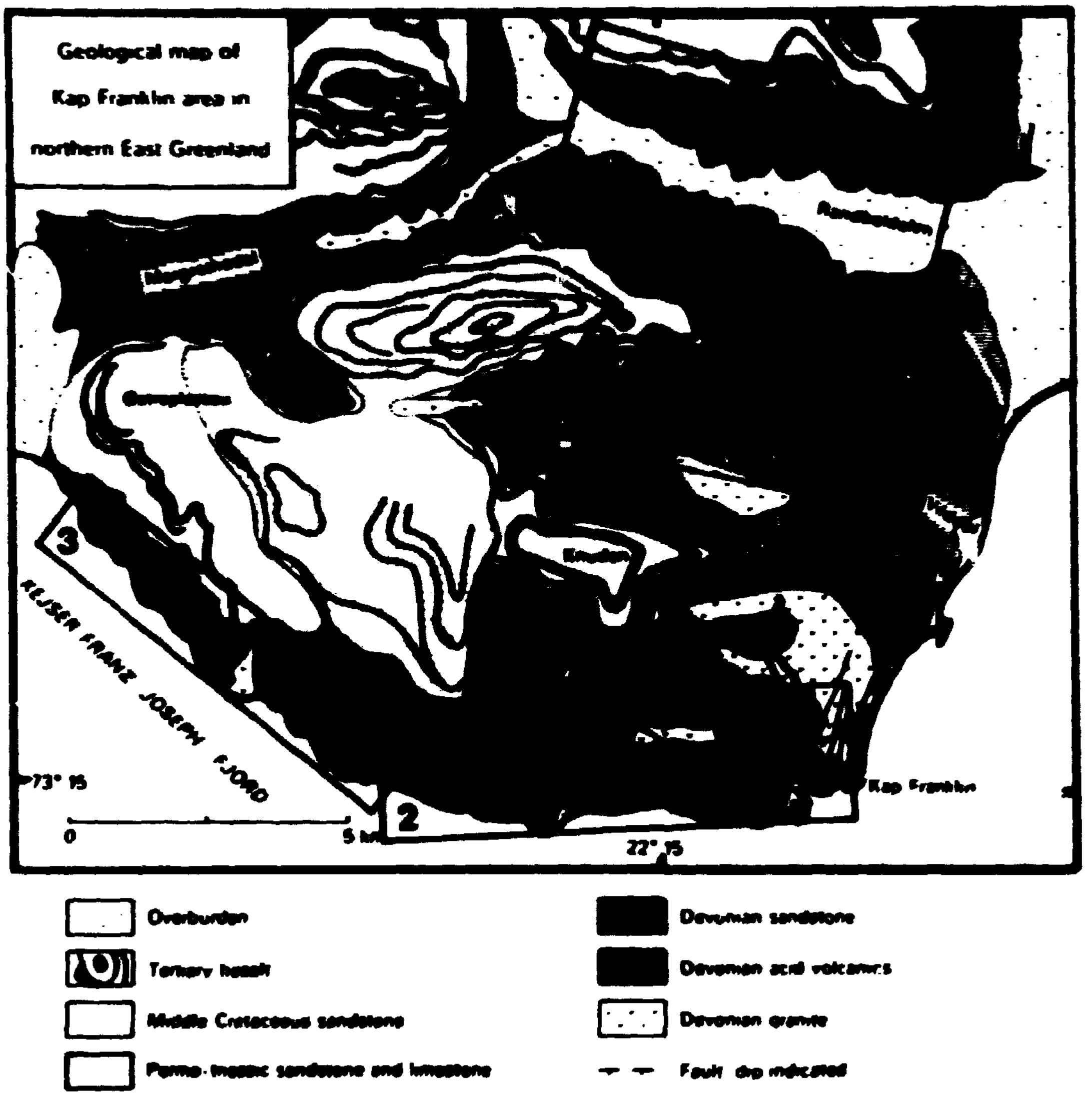


Fig. 1. Geological map of the Kap Franklin area, northern East Greenland based on a map published by Bütler (1954). The investigated areas are: (1) Randbøldal, (2) South of Knuden (S of K), (3) Kejser Franz Josephs Fjord (KFJ Fjord), and (4) Vilddal.

The deposition of the terrestrial sediments took place during the upper Middle and the Upper Devonian, shortly after the main Caledonian orogeny, and the sediments are thus equivalent to the Old Red Sandstone of Scotland. The fluviatile to partly lacustrine sediments comprise green and red banded siltstones, grey silt-stones, sandstones and conglomerates. Rapid lateral changes in facies are characteristic features.

A pronounced magmatic activity in the upper Middle Devonian re-sulted in extrusions of acid lavas, mainly rhyolites and pyro-clastics, and in the intrusion of a granite. Substantial parts of the rhyolites are altered, leached and weathered, and they are characterized by intense oxidation colouring in yellow, orange and red.

The Permian to Mesozoic marine succession consists mainly of light-coloured, lime-rich siltstones and claystones.

Table 1 shows the geochemistry of the most important types of rock from the Kap Franklin area with respect to the elements considered in the present context.

The mineralisation reported in the region is of limited extent. Haematite and pyrite are found in places along the contact be-tween the granites north of Kap Franklin and the surrounding contact-metamorphosed sediments, and are probably associated with the intrusion of the granite[5]. A number of roughly N-S skriking sulphide-bearing fluorite, quartz, haematite, baryte, strontianite and calcite veins occur along the coast of the Kej-ser Franz Josephs Fjord. These are considered to represent a late hydrothermal phase of the Devonian magmatism[5].

In the Randbøldal, E-W striking zones on either side of the valley are discontinuously mineralised with uraniferous hydro-carbons and uraniferous limonite[6]. Despite intense weathering of the host rhyolite, the grains of the hydrocarbons are unat-tacked by weathering. The mineralised rock has higher contents of zinc and lead than the barren rhyolites.

# 3. SAMPLING AND ANALYSIS

## 3.1. Sampling

### 3.1.1. Stream sediments

Predominantly active stream sediments were collected, where possible, from all tributories of a drainage system, usually above discharge points into major streams. These sediments generally consist of 30-40 per cent silt, 20-30 per cent clay, and coarse material; organic material is very rare.

The stream sediments were collected with a plastic shovel, poured into paper bags and stored in a rucksack-arrangement which allowed pre-drying during transport. The average sample weight was about 300 g.

### 3.1.2. Soil and seepage soil

Soil formation in East Greenland is rather sparse and limited to broad glacier-eroded valleys and delta areas of large rivers. However, soil is developed sporadically at break-in-slopes.

An A horizon, of a few cm in thickness, is usually underlain by a thin yellowish-brown clay-rich horizon that rests directly on the bedrock. In the Randbøldal area the soils were (a) well developed soils with A, B, and C horizons, (b) coarse clayish soil interbedded with horizons of coarse rock fragments, and (c) up to 20 cm thick humus-rich soil formations resting on very coarse rock fragments. Permafrost occurs at depths of about 1 m in soil formations in the broad valleys.

Soils developed in slope areas are often saturated with water during the snow-melting periods, producing typical seepage soils. On sunny days the water circulating in seepage soils may reach temperatures above 10°C and is likely to increase the chemical activity.

During the exploration surveys, soil and seepage soil samples were taken from below the A horizon. They were packed and air-dried in the same way as described for the stream sediments.

### 3.1.3. Water

Stream or seepage water samples were filled into 7 ml plastic containers at the sampling site. At the time of collection the water temperatures varied between 0.5 and 8°C, the seepage water generally having the higher temperatures. The water was usually clean, but occasionally very fine undissolved matter occurred, often depending on the daily change in snow-melting activity. Measurements of the pH of the water samples were carried out with a pH-meter in the field. pH-paper is useless in this arctic region because of the low concentration of ions in the melt water.

### 3.1.4. Registration of field data

To register pertinent field data, a simplified form of field geochemistry card (Fig. 2) was used based on the Geological Survey of Canada field cards. Parameters recorded were area code, kind of sample, sample number, characteristic parameters of the sample, e.g. fractional composition of the sample (gravel, sand, silt, clay, organic material), pH-value, air and water temperatures, radiation level, altitude and coordinates of the sampling site, code for the geological environment, and date of sample collection. These data were converted into punched 80-digit paper cards after the end of the field season and tabulated by means of a computer program.

### 3.2. Analysis

V, Cu, Zn and Pb in the <180μm (-80 mesh) fraction of stream sediments, soil and seepage soil samples were determined by atomic absorption spectrophotometry (AAS) using a standard procedure[7].

A slightly modified method was applied for the determination of Cu, Zn and Pb in water samples, partly because of the low con-

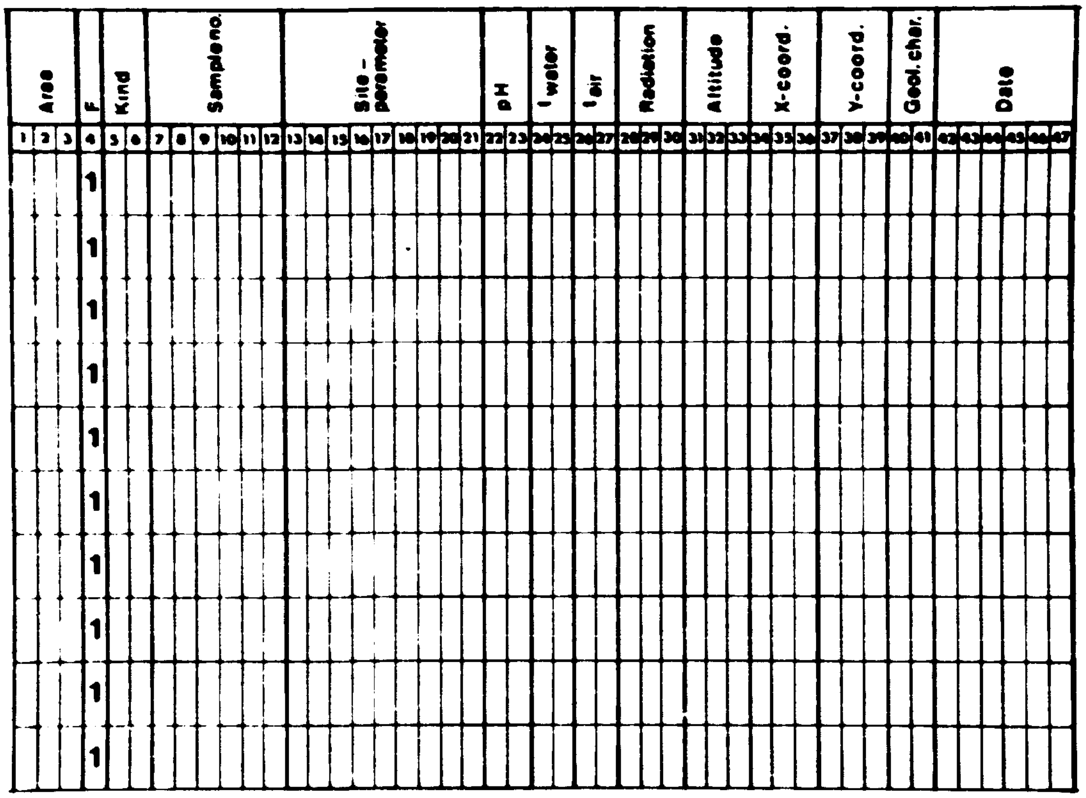


Fig. 2. Layout of a field geochemistry card for registration of the field data for 10 samples. For water samples, collection site parameters are width of the stream, depth of the stream, velocity (high, normal or low), stream flow rate (high, normal or low), and transparency of the water (transparent or muddy).

centrations of these elements in the water samples. For the analysis of Cu and Pb, a flameless AAS method[8] was adopted yielding detection limits of the order of $10^{-12}$ g. Only a few water samples had to be filtered before analysis; generally, chemical interference was avoided by the use of high atomising temperatures. Other matrix interference could be regarded as negligible. The magnitude of background absorption was controlled by using a background compensator. Artificial standards of 10, 50 and 100 ppb (1 ppb = 1 part per $10^9$) Cu, Zn and Pb dissolved in distilled water were used.

For the analysis of K, Ca, Ti, Mn and Fe in stream sediments, soils and rocks, use was made of a radioisotope EDX unit coupled to an automatic sample changer with capacity for 48 samples[9].

The analytical system was calibrated with -200-mesh standard rock samples supplied by the U.S. Geological Survey. About 20 g of -80-mesh sample material was needed for analysis. X-ray spectral data were stored automatically on punched paper tape and then treated by a computer program. The time of analysis was 2000 s per sample.

A delayed-neutron counting facility installed at the Risø reactor DR 3 was used for uranium analysis. About 10 g of -80-mesh stream sediments and soils were needed for analysis.

## 4. RESULTS AND DISCUSSION

### 4.1. Stream sediments

One hundred and fourty-two stream sediments were collected in the four drainage areas in 1974.

The grain size distributions were examined in 11 selected samples (Table 2). The majority of the samples showed increasing contents of V, Cu, Zn and Pb with decreasing grain size, and the average enrichment factor, defined as the ratio of metal content in the <50μm fraction to that in the >200μm fraction, was about 2 for each of the four metals. The <180μm (-80 mesh) fraction was used in the present study.

The analytical data for K, Ca, Ti, Mn and Fe[10] are compiled in Table 3. The concentrations of these elements in the stream sediments are in reasonably good agreement with the respective concentrations in the bedrocks (Table 1). There is, however, a tendency for increased content of Mn and Fe in the stream sediments.

Table 1. Concentrations of selected elements in rocks of the Kap Franklin area.

| Rock type | Number of samp. | K (%) | Ca (%) | Ti (%) | Mn (ppm) | Fe (%) | V (ppm) | Cu (ppm) | Zn (ppm) | Pb (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Rhyolite | 13 | 5.1 | 0.7 | 0.1 | 170 | 1.6 | | 10 | 55 | 45 |
| Granite | 3* | 3.3 | 1.4 | 0.3 | 120 | 3.3 | | | 25 | 30 |
| Sandstone | 2 | 2.7 | 23.4 | 0.3 | 480 | 2.2 | 25 | 25 | 70 | 30 |
| Basalt | 2 | 0.7 | 7.4 | 1.2 | 1620 | 9.0 | 390 | 140 | 100 | 15 |
| Agglomerate | 1 | 4.7 | 4.0 | 0.1 | 150 | 4.7 | | | 100 | |

*includes two samples compiled in 4.

Table 4 contains the analyses for V, Cu, Zn and Pb[11], and the estimated values for background and threshold[12,16]. When background values are compared to the bedrock geochemistry, no significant deviations are displayed, but Cu seems to be slightly enriched and Pb to be slightly depleted in the stream sediments.

Table 2. Average grain size distribution calculated from the grain size distributions of 11 selected stream sediment samples from the Kap Franklin area.

| Grain size | > 200 µm | 100–200 µm | 50–100 µm | < 50 µm |
|---|---|---|---|---|
| Percentage | 49 | 19 | 29 | 3 |

Local background and threshold values are nearly the same for Randbøldal, Vilddal and the KFJ area, but significantly lower values for V, Cu and Zn are observed for the S of K area. This pattern must be explained by differences in the bedrock geology. Higher-than-average threshold values for Cu and Zn are found for the Vilddal and the S of K areas, respectively.

The plots in figures 3 to 6 show the regional distribution of the metals. V is fairly evenly distributed, with one anomalous site located in the north-western part of the Randbøldal. Generally, the western and the eastern parts of the Randbøldal and the S of K area, respectively, have the highest V contents in stream sediments. Likewise, only few weak Cu anomalies are observed, but they are of scattered occurrence, the highest Cu contents are found in samples from areas with high V. Zn and Pb show similar distribution patterns. There are a few anomalies in central and eastern Randbøldal, and two anomalies in Vilddal that are noteworthy because of their coincidence with Cu anomalies. Finally, there are a few anomalies in the southern areas.

## 4.2. Soil and seepage soil

Forty-two soil and seepage soil samples were collected and the < 180 µm fractions were analysed.

Compared to the stream sediments (Table 3), the soil samples characteristically have lower average Ca contents and significantly higher Fe contents. The contents of K and Ti are in general similar in the two types of sample.

Table 3. Analytical data for K, Ca, Ti, Mn and Fe in stream sediments, soil and seepage soil samples from the Kap Franklin area (1974).

| Area | Type of Sample | K (%) | | Ca (%) | | Ti (%) | | Mn (ppm) | | Fe (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Range | Average | Range | Average | Range | Average | Range | Average | Range | Average |
| Randbøldal | Stream sed. (61) | 1.3-3.8 | 2.6±0.5 | 1.3-8.4 | 3.3±1.5 | 0.3-1.4 | 0.5±0.2 | 360-1100 | 610±150 | 2.6-6.4 | 4.0±0.8 |
| | Soil/seep. (14) | 1.9-3.4 | 2.6±0.5 | 0.8-2.2 | 1.4±0.4 | 0.4-0.7 | 0.5±0.1 | 490- 900 | 640±120 | 3.5-5.4 | 4.7±0.5 |
| Vilddal | Stream sed. (14) | 1.3-3.3 | 2.5±0.5 | 1.1-4.7 | 2.6±1.0 | 0.4-0.9 | 0.5±0.1 | 560-1000 | 730±140 | 3.4-5.2 | 4.4±0.5 |
| S of K | Stream sed. (36) | 1.8-5.0 | 3.2±0.6 | 0.7-3.9 | 2.3±1.1 | 0.2-0.9 | 0.4±0.1 | 300- 800 | 470±130 | 1.9-4.3 | 2.8±0.7 |
| | Soil/seep. (17) | 2.0-4.0 | 3.0±0.7 | 0.7-2.0 | 1.2±0.3 | 0.3-0.5 | 0.4±0.1 | 240-1000 | 600±210 | 2.9-6.4 | 3.9±0.8 |
| KFJ Fjord | Stream sed. (31) | 0.9-3.9 | 2.2±0.7 | 0.7-7.5 | 2.2±1.6 | 0.3-0.6 | 0.4±0.1 | 400-1300 | 700±180 | 2.4-5.8 | 3.9±0.7 |
| | Soil/seep. (17) | 1.3-4.3 | 2.4±0.9 | 0.5-2.0 | 1.0±0.4 | 0.3-0.6 | 0.4±0.1 | 470- 910 | 690±130 | 3.3-6.1 | 4.4±0.9 |
| Kap Franklin | Stream sed. (142) | 0.9-5.0 | 2.6±0.7 | 0.7-8.4 | 2.7±1.4 | 0.2-1.4 | 0.5±0.1 | 300-1300 | 610±170 | 1.9-6.4 | 3.7±0.9 |
| | Soil/seep. (49) | 1.3-4.3 | 2.7±0.7 | 0.5-2.2 | 1.2±0.4 | 0.3-0.7 | 0.4±0.1 | 240-1000 | 620±190 | 2.9-6.4 | 4.3±0.8 |
| | All samp. (191) | 0.9-5.0 | 2.7±0.7 | 0.5-8.4 | 2.4±1.4 | 0.2-1.4 | 0.5±0.1 | 240-1300 | 620±170 | 1.9-6.4 | 3.9±0.9 |

Number of samples in parentheses.

Local background and threshold values for V, Cu and Zn are slightly and for Pb significantly higher than the respective values for the stream sediments (Table 4).

Table 4. Estimated background (b) and threshold (t) values** for V, Cu, Zn and Pb in stream sediments and soil and seepage soil samples of the Kap Franklin area (1974).

| Area | Sample kind | V (ppm) | | Cu (ppm) | | Zn (ppm) | | Pb (ppm) | |
|---|---|---|---|---|---|---|---|---|---|
| | | b | t | b | t | b | t | b | t |
| Randbøldal | Stream sed. | 45 | 110 | 45 | 90 | 50 | 100 | 15 | 40 |
| | Soil/seep. | 55 | 105 | 40 | 90 | 55+ | 125+ | 30 | 60 |
| Vilddal | Stream sed. | 50 | 90 | 50 | 125 | 65 | 110 | 20 | 50 |
| S of K | Stream sed. | 25 | 105 | 15 | 65 | 25+ | 210+ | 15 | 40 |
| | Soil/seep. | 50 | 80 | 30 | 80 | 65+ | 140+ | 30 | 100 |
| KFJ Fjord | Stream sed. | 55 | 85 | 40 | 75 | 70 | 130 | 25 | 45 |
| | Soil/seep. | 60 | 80 | 40 | 90 | 95 | 270 | 40 | 130 |
| Kap Franklin | Stream sed. | 45 | 100 | 30+ | 80+ | 50 | 120 | 20 | 50 |
| | Soil/seep. | 55 | 80 | 40 | 85 | 80+ | 210+ | 30+ | 80+ |
| | All samp. | 45 | 100 | 30 | 80 | 60+ | 180+ | 25+ | 85+ |

+ Two distinct populations observed; number of samples is given in table 1.

**Calculation procedures for b and t given in [12,16].

Analytical data for soil and seepage soil samples are plotted together with the stream sediment data (figures 3 to 6). Two of the three V anomalies lie within the area in the north-western Randbøldal that is outlined by anomalous stream sedi-

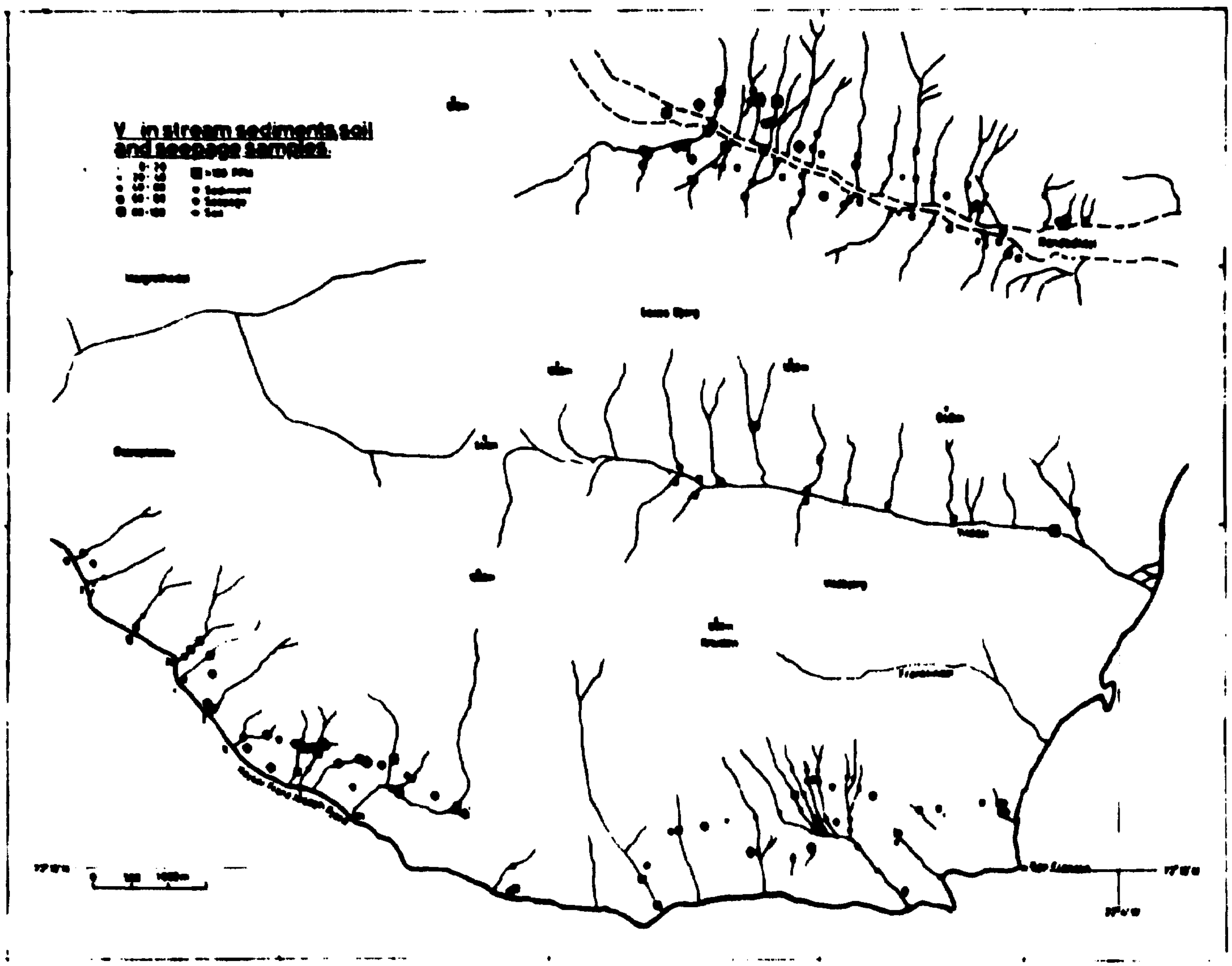


Fig. 3. V in stream sidements, soil and seepage soil samples of the Kap Franklin area.

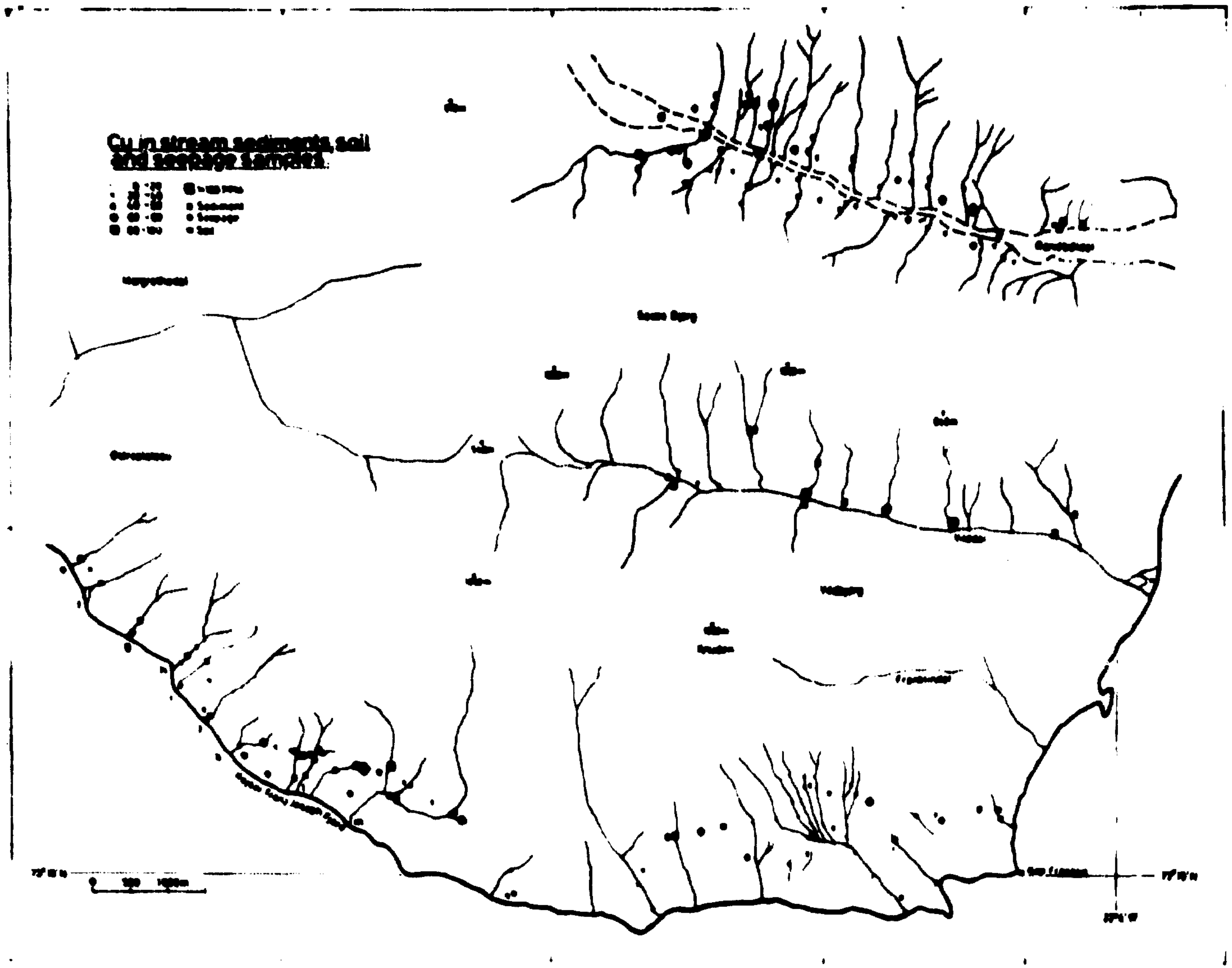


Fig. 4. Cu in stream sediments, soil and seepage soil samples of the Kap Franklin area.

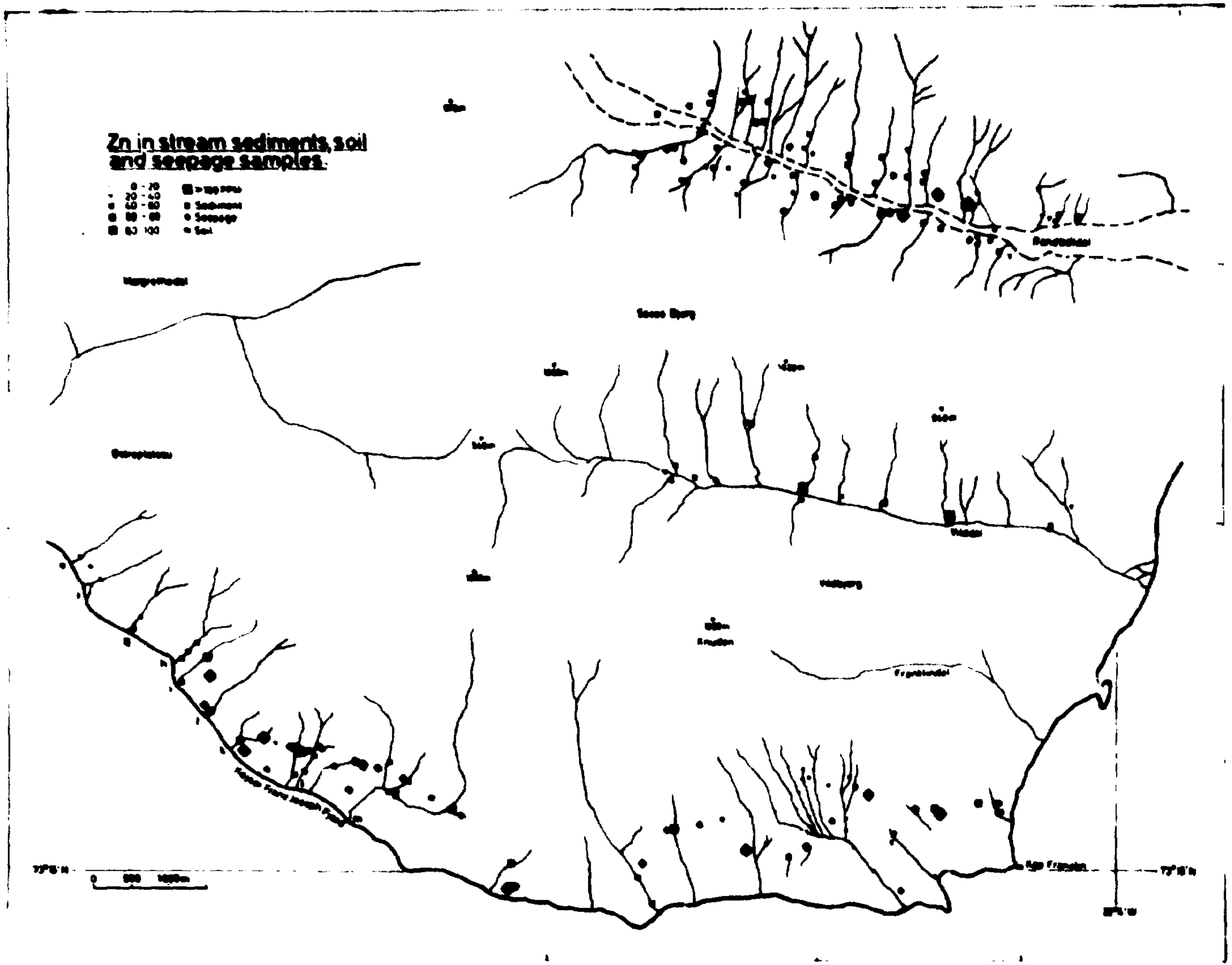


Fig. 5. Zn in stream sediments, soil and seepage soil samples of the Kap Franklin area.

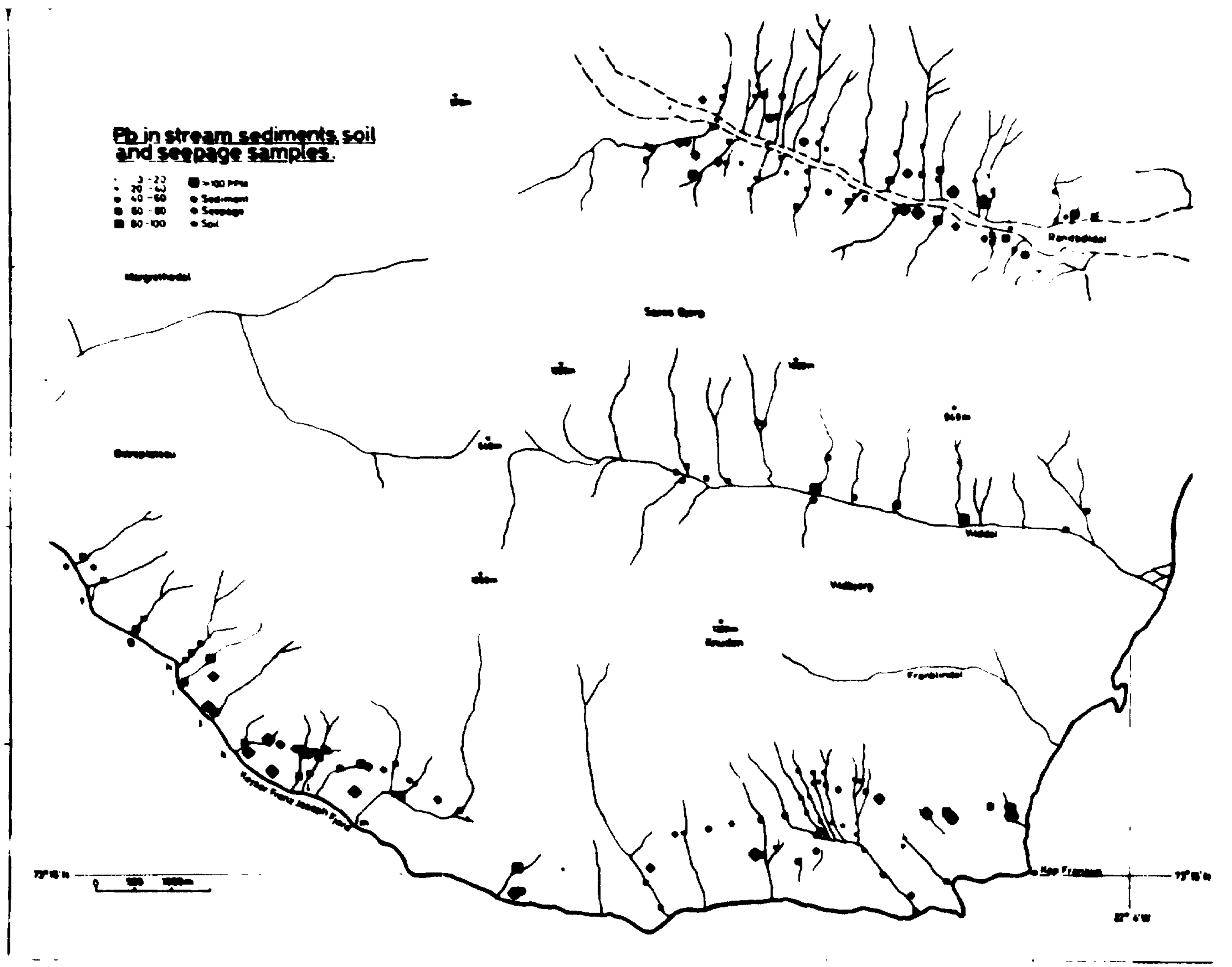


Fig. 6. Pb in stream sediments, soil and seepage soil samples
of the Kap Franklin area.

ments. The third sample with high V located in the KFJ Fjord area also has a high Cu content. Zn and Pb show more varied distribution patterns, resembling the Zn and Pb distribution patterns for stream sediments. There is a small cluster of Zn and Pb anomalies in central Randbøldal, the remaining anomalies are scattered along the south coast, particularly of the KFJ Fjord area. The Zn-Pb pattern observed could be connected to the fault system (fig. 1).

## 4.3. Water

One hundred and eleven water and 36 seepage water samples were collected and analysed for Cu, Zn and Pb[13].

Analytical results for Cu and Zn are given as histogrammes in fig. 7. No differences were observed in metal contents between stream and seepage waters. A difference might have been expected because of the higher temperatures and hence greater dissolving ability of seepage waters.

Regional background and threshold values for Cu and Zn in water samples are plotted in figures 8 and 9. Only the samples from river f and the first eastern tributary to river m of the KFJ Fjord area have Cu contents above the threshold value (38 ppb). Generally, samples from this area have increased Cu contents, but no clear pattern could be established for Cu in water samples. With respect to Zn, three samples from the north-eastern part of the Randbøldal and a sample from the central part of the S of K area are anomalous (> 25 ppb Zn). Thirty-three water samples had detectable Pb concentrations and more than one half of these samples were lower than 5 ppb. Higher contents were detected in the samples from rivers e and f, 8 and 30 ppb, respectively. One sample from the central part of the S of K area (marked Pb in fig. 9) contained as much as 156 ppb Pb.

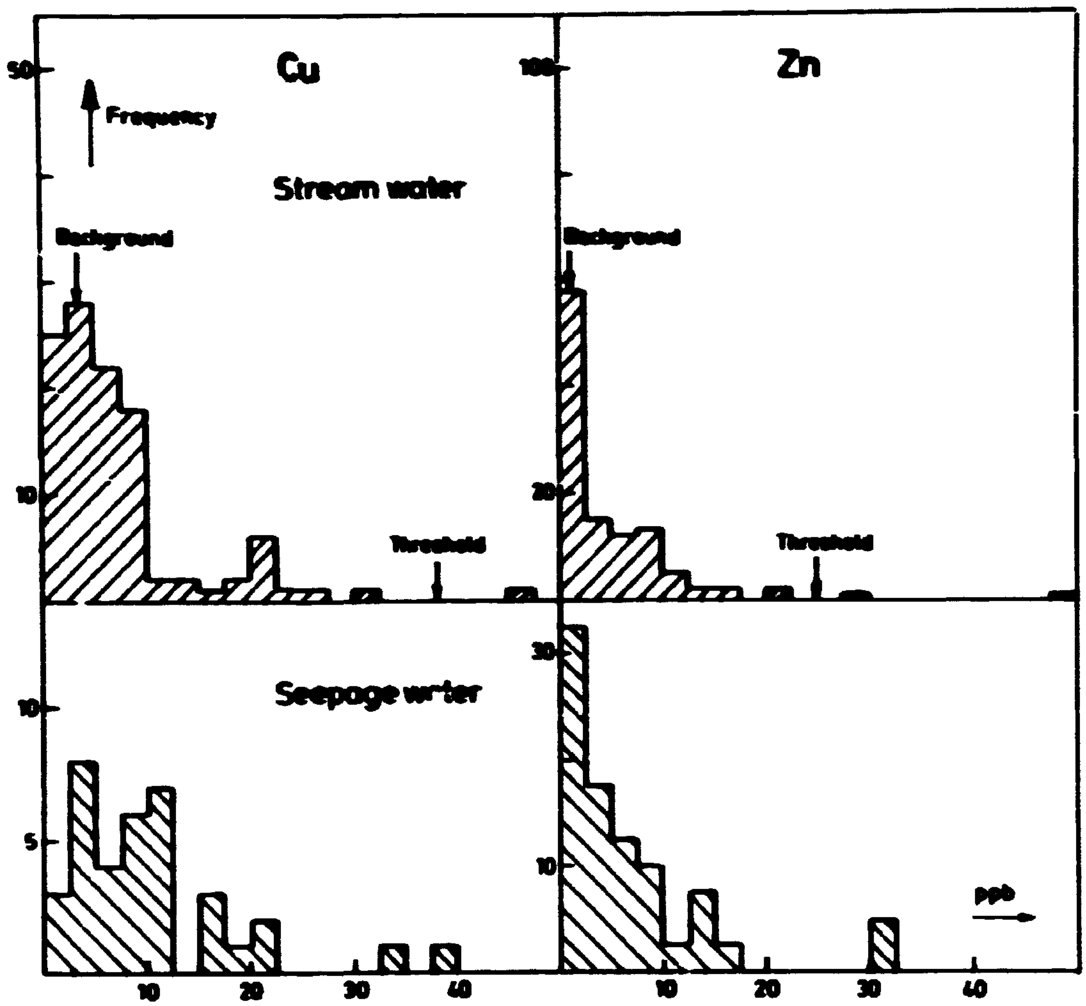


Fig. 7. Histogrammes for Cu and Zn in stream and seepage water samples of the Kap Franklin area.

## 4.4. Discussion

The similarity in the chemistry of the bedrock, of the stream sediments and of the soils stongly suggests that mechanical transport is the most important geochemical dispersion mechanism. However, the small differences noted (low Ca and high Fe) in soils and seepage soils are taken to indicate that ionic transport does take place to a limited extent in addition to the mechanical transport. This implies that only narrow dispersion halos are formed. Therefore, very dense sampling must be employed in order to trace smaller mineralisations.

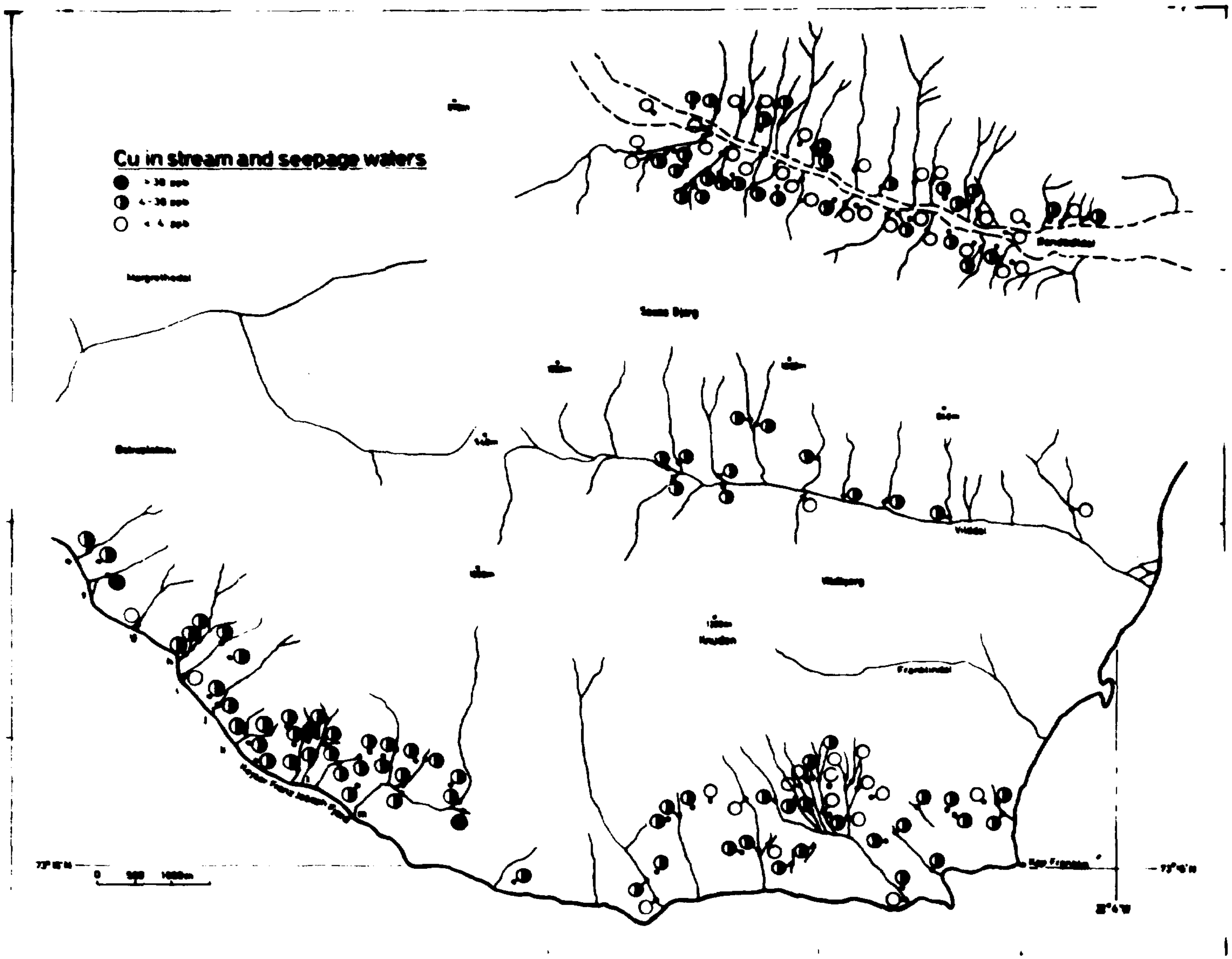


Fig. 8. Cu in water samples of the Kap Franklin area.

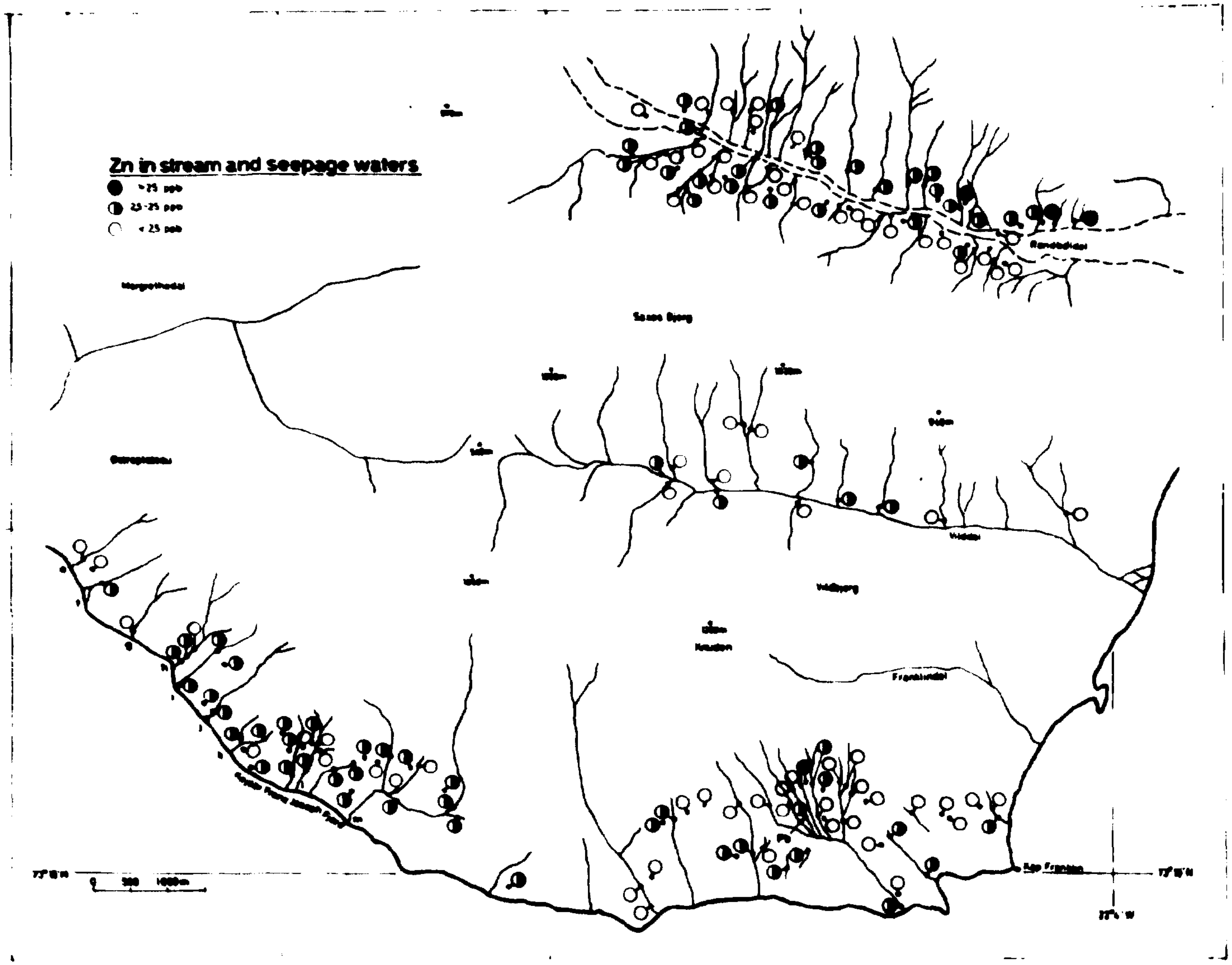


Fig. 9. Zn in water samples of the Kap Franklin area.

Small mineralisation areas known in the region are not usually registered in the adjacent tributaries, possibly because the mineralisations are of limited extent and too far from the sampling site. The regional distributions of the metals in stream sediments and soils and those of the metals in water generally differ. Some of the high metal contents in stream sediments and soils, such as the high V in sediments and soils from the western part of the Randbøldal, can be explained by a specific bedrock chemistry. Others, like anomalous Cu, Zn and Pb stream sediment samples, may indicate the presence of sulphide mineralisations[15]. Some anomalies, e.g. the very high Pb concentration in the water from the central part of the S of K area, cannot be explained by a local mineralisation.

Uranium mineralisation in the eastern and southern central part of the Randbøldal area was traced by weak, anomalous U contents in stream sediments, and moderate to strong anomalous U contents in water and seepage soil samples[14]. As mentioned earlier, Zn and Pb accompany the uranium mineralisation, and in seepage soils and stream sediments of this area both Zn and Pb were anomalously high. However, there was no response in water to Zn and Pb.

The geochemical data of the reconnaissance study point to Randbøldal, the eastern part of the KFJ Fjord area, and the westernmost and easternmost part of the S of K area as possible subareas for detailed follow-up work.

# 5. DETAILED INVESTIGATIONS IN THE RANDBØLDAL IN 1975

## 5.1. The stream sediment survey

To investigate the mineralisation in the Randbøldal in greater detail, a stream sediment survey was carried out in 1975. A geological map of the area is given in Fig. 10. To simplify the discussion, names have been introduced for some of the tributaries to the Randbøldal river.

One hundred and fifty-seven samples were analysed for U, Cu, Zn and Pb. A comparison of local background and threshold values of the reconnaissance study in 1974 and the detailed survey of the Randbøldal in 1975 is given in Table 5. These values are rather similar.

Table 5. Comparison of background (b) and threshold (t) values for Cu, Zn and Pb in stream sediments from Randbøldal taken in 1974 and 1975.

| Year of collection | Number of samples | | Cu (ppm) | Zn (ppm) | Pb (ppm) |
|---|---|---|---|---|---|
| 1974 | 45 | b | 45 | 50 | 15 |
| | | t | 90 | 100 | 40 |
| 1975 | 157 | b | 35 | 65 | 30 |
| | | t | 70 | 90 | 50 |

Analytical data of the detailed stream sampling survey are given in figures 11 and 12. Uranium mineralisation can be traced through high U contents (> 6 ppm) in stream sediments from the Munin, Tango and Saxo rivers. However, two samples with U contents greater than 10 ppm were found in tributaries to the Munin and the Store at higher topographic levels. For Cu, analytical data display good agreement with the results of the 1974 survey (Fig. 4 and Fig. 11): increased Cu contents were found in samples from the north-western part of the area. Anomalously high Cu was detected in a sample of a tributary of the river between the Magnus and Teater rivers. The highest Zn contents were observed in samples from the Tango (Fig. 12), which in 1974 yielded significantly

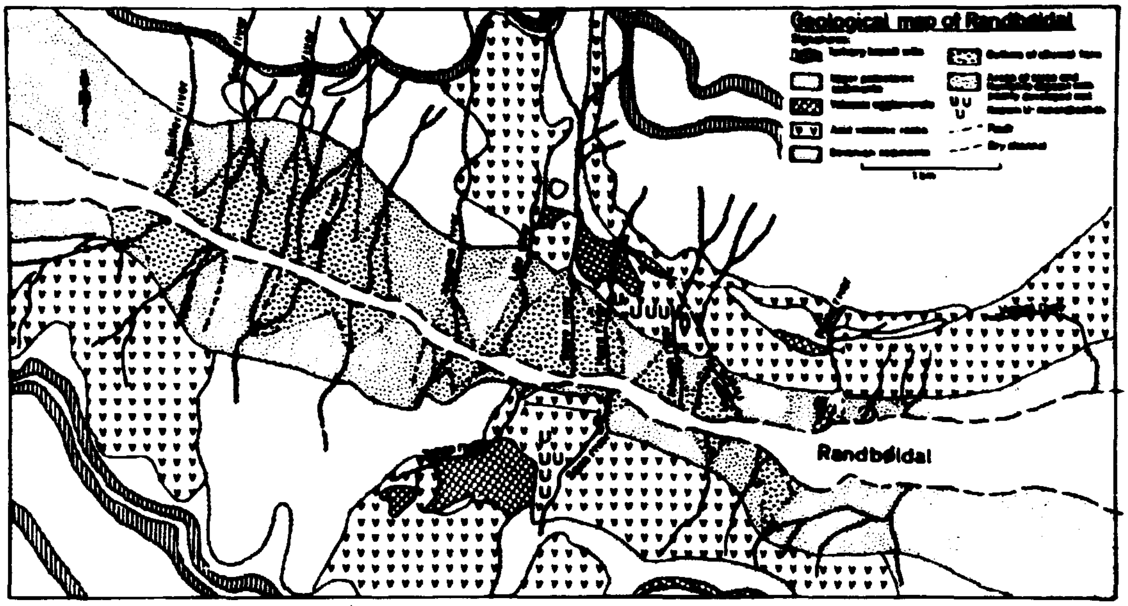


Fig. 10. Geological map of the Randbøldal.

lower values for Zn (Fig. 5). For the majority of samples from both surveys, however, Zn contents are at the same level for respective parts of the area, and good agreement is achieved. Many of the samples taken in 1975 have low Pb contents (Fig. 12) and there is quite often disagreement between the results of the 1974 (Fig. 6) and the 1975 survey. Different analytical procedures are one explanation for this. In particular, samples from the Tango have high Pb contents, which is not in agreement with the results of 1974, and many of the samples from the north-western part of the Randbøldal display the same tendency for high Pb contents. The highest Pb content was found in a sample from the second south-eastern tributary, and in general this area is characterised by high Pb stream sediment samples.

A test of daily and weekly variations of metals in stream sediments from one locality in the Munin and a locality in the Randbøldal river, at the point of discharge of the Munin, was carried out during the 1975 field season. The changes in Cu, Zn and Pb contents during the period of the investigation were normally less than 10 per cent.

In summary, there is reasonable agreement between the results of the reconnaissance study of 1974 and the detailed sampling survey

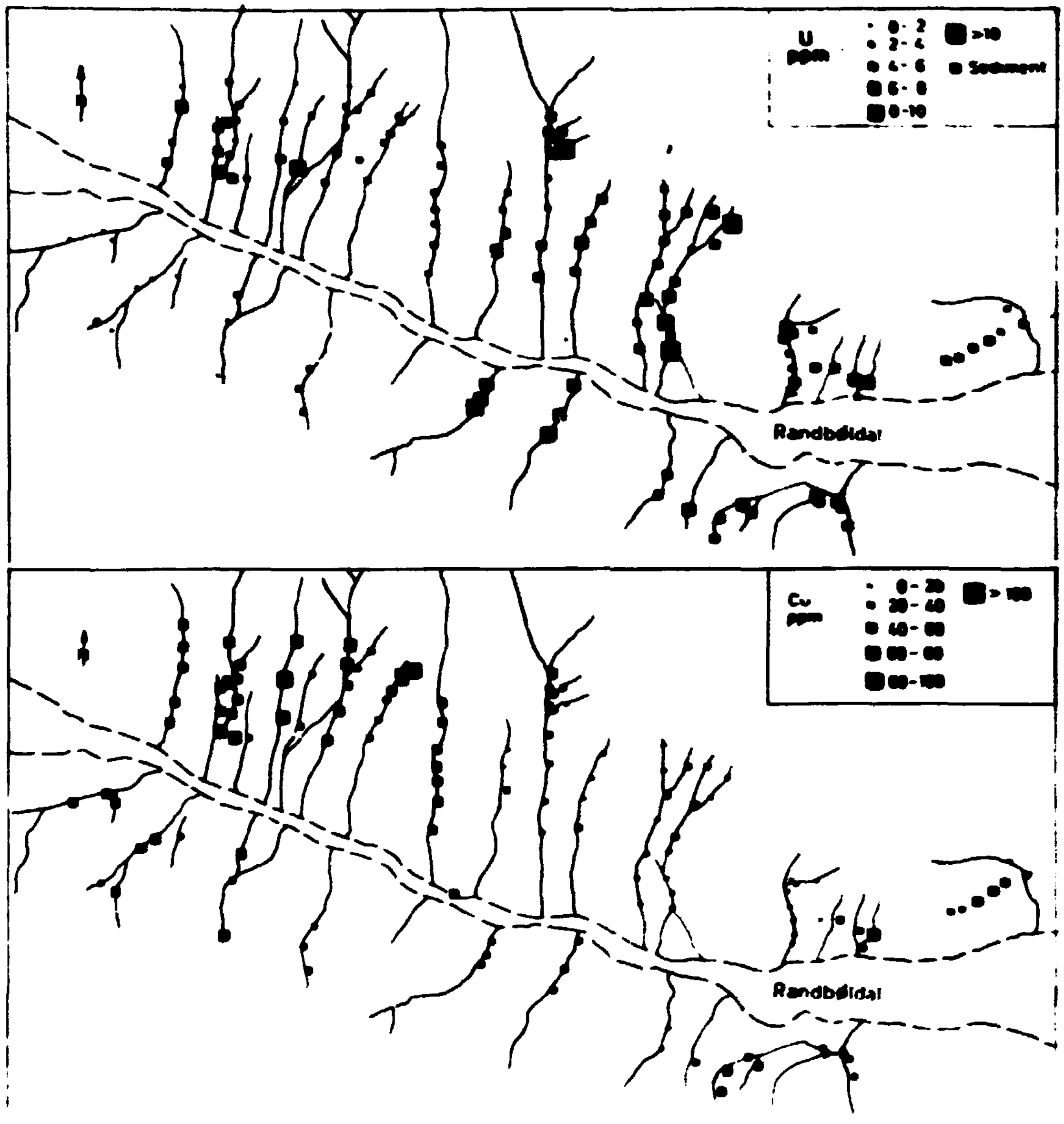


Fig. 11. U and Cu in stream sediments from the Randbøldal.

made in the Randbøldal in 1975. The distribution patterns for Cu, Zn, Pb and U are displayed more clearly by means of the detailed sampling, and the analytical data outline very rapidly downstream-decreasing metal contents. Additional U mineralisation is likely to be present in the close vicinity of the two U anomalies in the upper parts of the Store and Munin rivers.

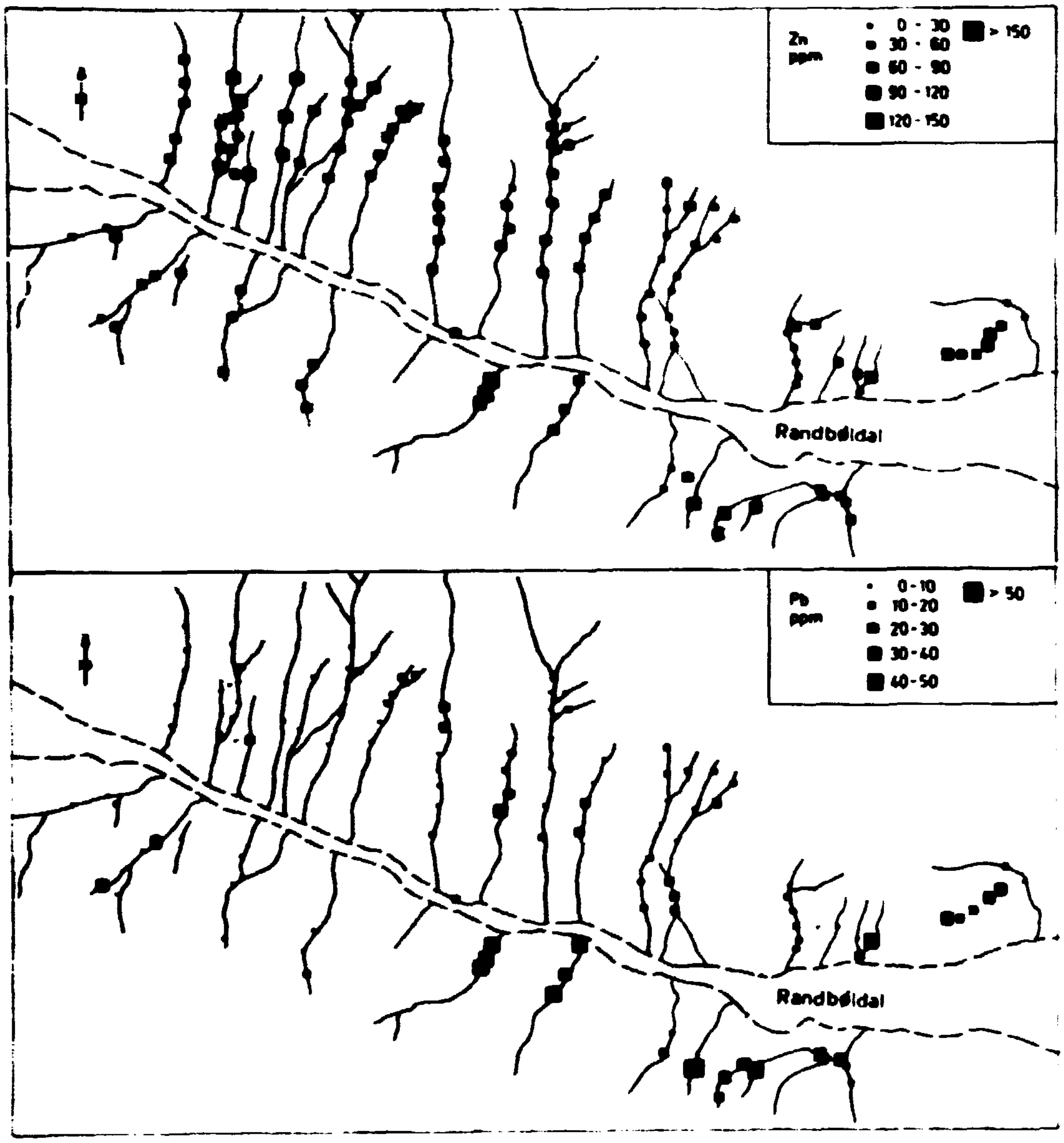


Fig. 12. Zn and Pb in stream sediments from the Randbøldal.

## 5.2. Soil sampling traverses

Two hundred and fifty-three soil samples on 15 traverses with distances between sampling sites of about 10 m were collected in areas with known U mineralisation. The traverses cover the areas between the rivers Store and Potte and between the rivers Saxo and Tango (Fig. 10).

Analytical results for U, Zn and Pb along the traverses between the Store and the Potte are plotted in Figs. 13 to 15. Thirty-one samples with U contents of above the estimated threshold value (15 ppm) originated from the rhyolite area between the Munin and the Hugin, west of a N-S trending fault following the Munin. Increasing U contents were found in samples taken from south to north between the Store and the Hare. This trend was also observed in stream sediments from the Munin and the Store near the contact of the rhyolites to the Devonian sediments (Fig. 11). Soils with high U contents have Zn contents above 120 ppm; soils from the U mineralised area contain 200-300 ppm (figures 12 and 14).

The distribution of Cu, Zn and Pb in soils originating from an E-W soil sampling traverse between the Saxo and Tango rivers is given in Fig. 16. The two Zn and Pb maxima correspond to the anomalously high Zn and Pb values found in seepage samples during the reconnaissance study of 1974, and to an observed radiometric anomaly[14].

Generally, the analytical data from soil sampling traverses clearly outline the extent of the U mineralisation between the Munin and the Hare rivers. Very high Pb and moderately high Zn contents are associated with anomalous U samples.

Because almost all soil and seepage soil samples with high U contents from the 1974 and 1975 surveys in Randbøldal are enriched with Pb and Zn, these two elements may be regarded as indicator elements for the U mineralisation. Further exploration is recommended in the anomalous areas.

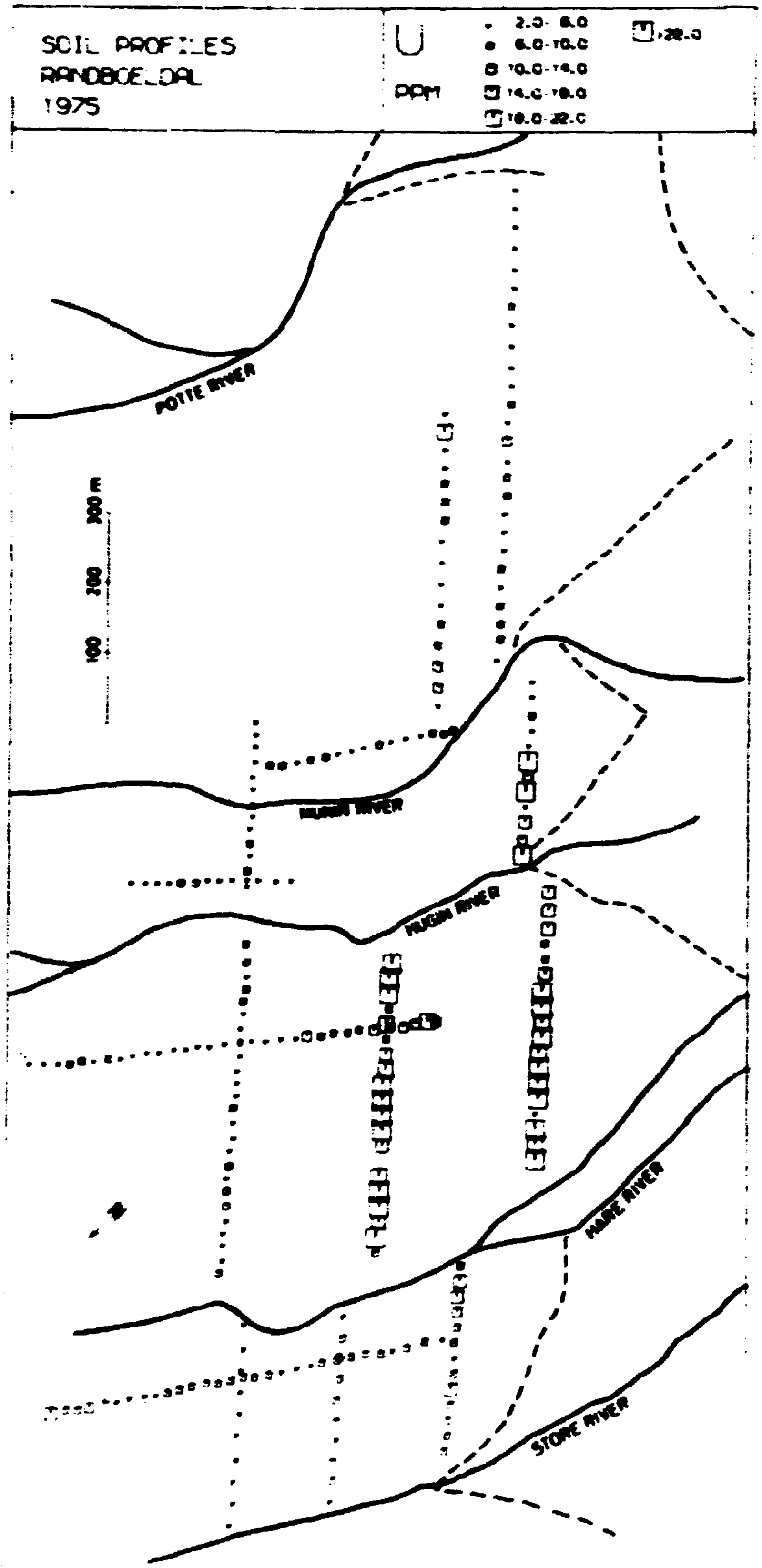


Fig. 13. U in samples from soil sampling traverses in the northern central part of the Randbøldal.

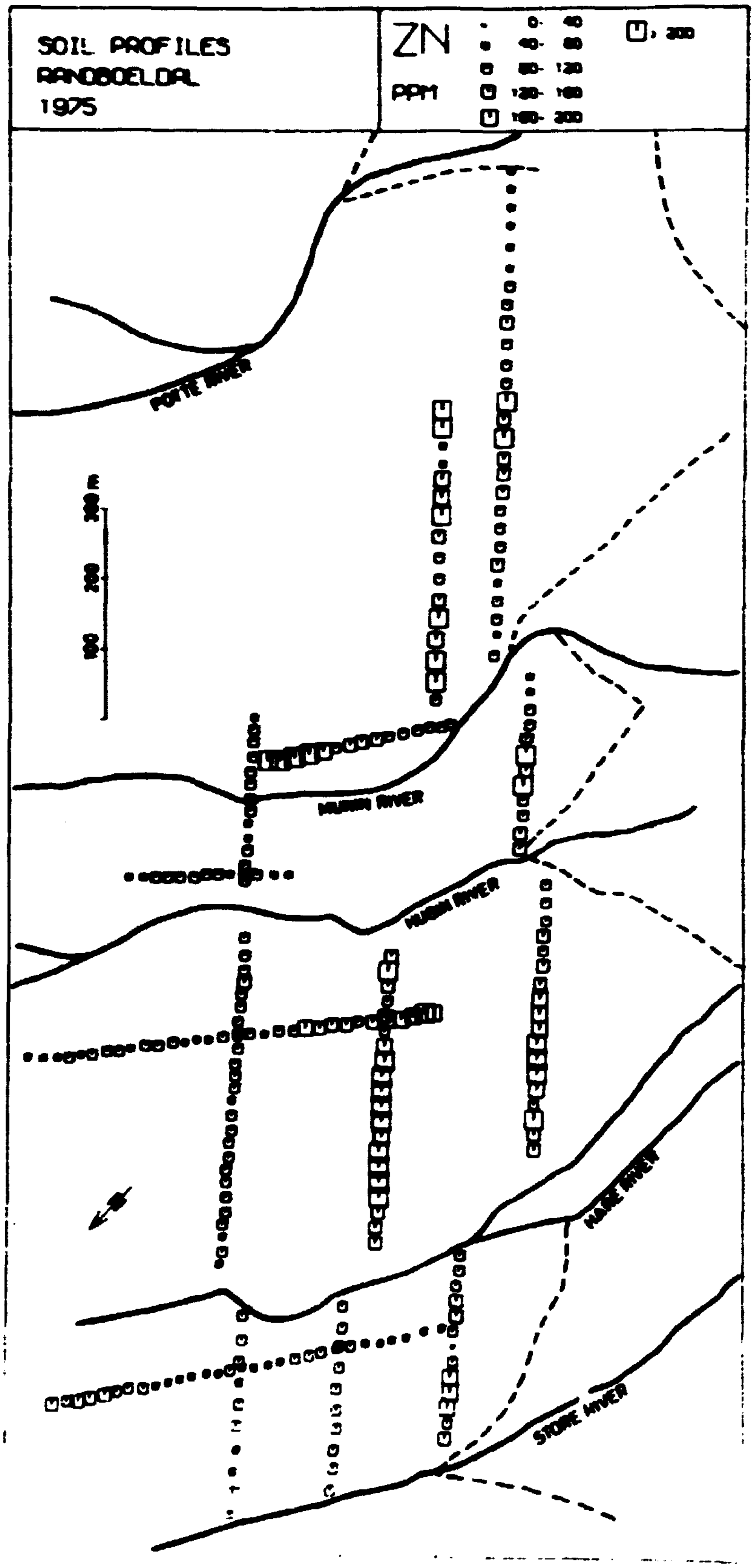


**Fig. 14. Zn in samples from soil sampling traverses in the northern central part of the Randbøldal.**

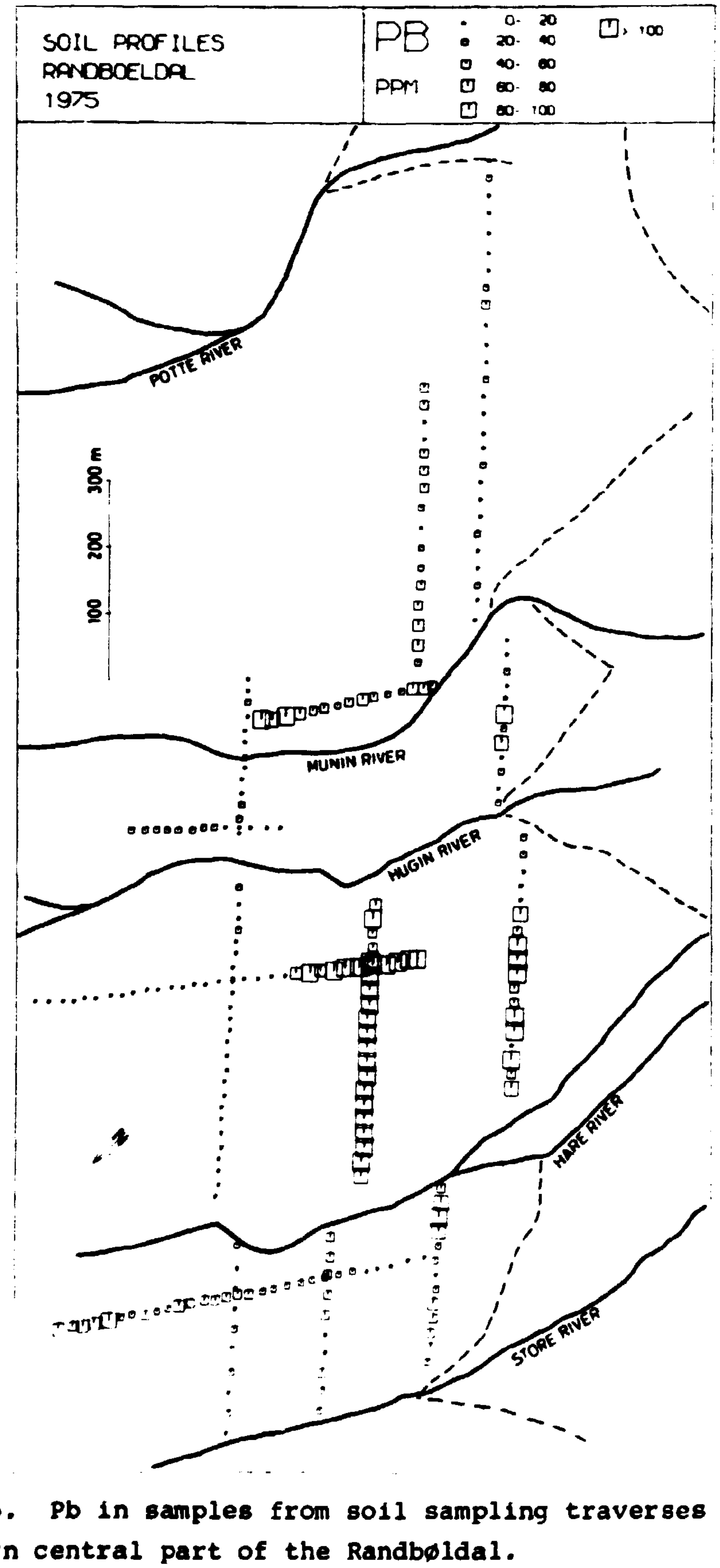


Fig. 15. Pb in samples from soil sampling traverses in the northern central part of the Randbøldal.

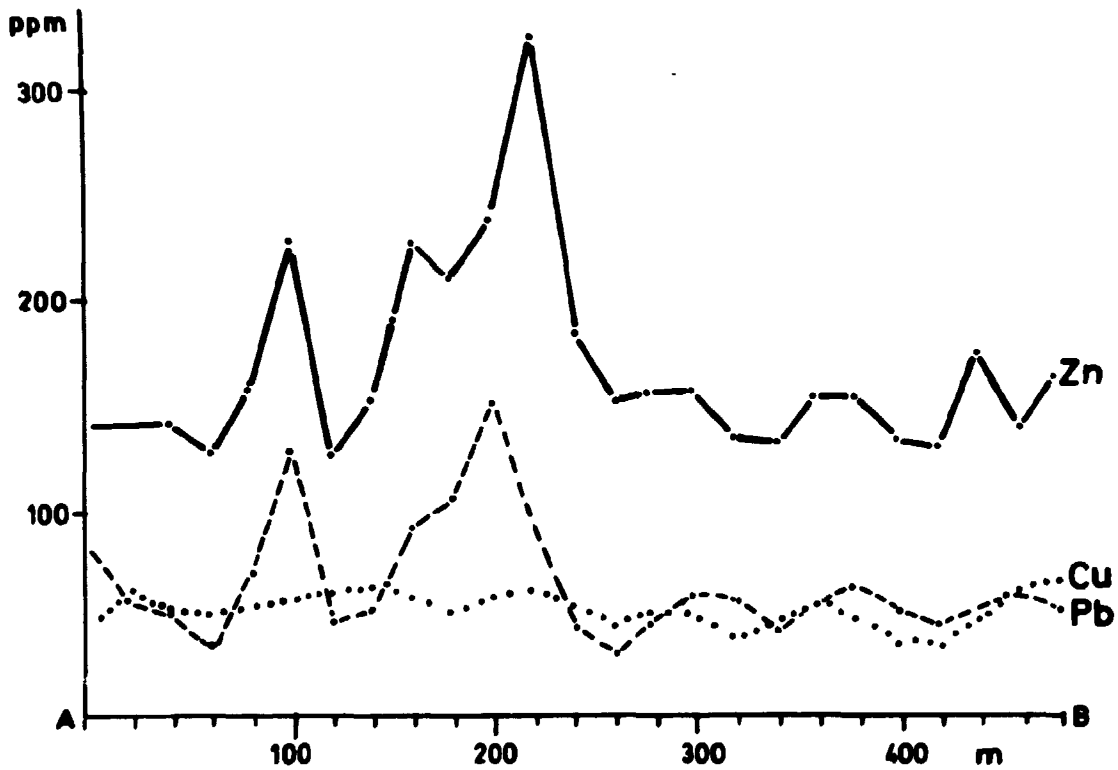


Fig. 16. Distribution of Cu, Zn and Pb in samples along an E-W soil sampling traverse between the Tango and the Saxo rivers in the southern central part of the Randbøldal. The position of the traverse is marked A-B in fig. 10.

## 6. CONCLUSIONS

About 800 stream sediments, water, soil and seepage soil samples were collected during the field seasons of 1974 and 1975 in the Kap Franklin area, northern East Greenland. The samples were analysed for Cu, Zn, Pb and in part for U, V, K, Ca, Ti, Mn and Fe.

The reconnaissance study in 1974 outlined the areas where mineralisation is known to occur: Randbøldal and areas east and west of Kap Franklin. Analytical data on stream sediments indicate predominantly mechanical transport yielding only narrow dispersion halos. Therefore, dense sampling must be applied. In areas with soil development, soil and seepage soil sampling is advantageous because this enhances the demarcation of anomalous areas deduced from stream sediment sampling surveys. Mineralised areas in the Randbøldal are clearly outlined by anomalous metal contents in samples from systematic soil sampling traverses in these areas.

Water sampling was effective for U in the Randbøldal, whereas the usefulness of Cu, Zn and Pb water geochemistry was not proved.

Our investigation demonstrates that geochemical techniques are applicable in the arctic environment of northern East Greenland, and that geochemical sampling is a useful and effective supplement to methods of geological and geophysical prospecting.

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